



Scheduling Activity Phase

Guy Swope

David Hyde

Tony Cetuk

Neil Clabough

14 December 1994

Scheduling Activity Phase



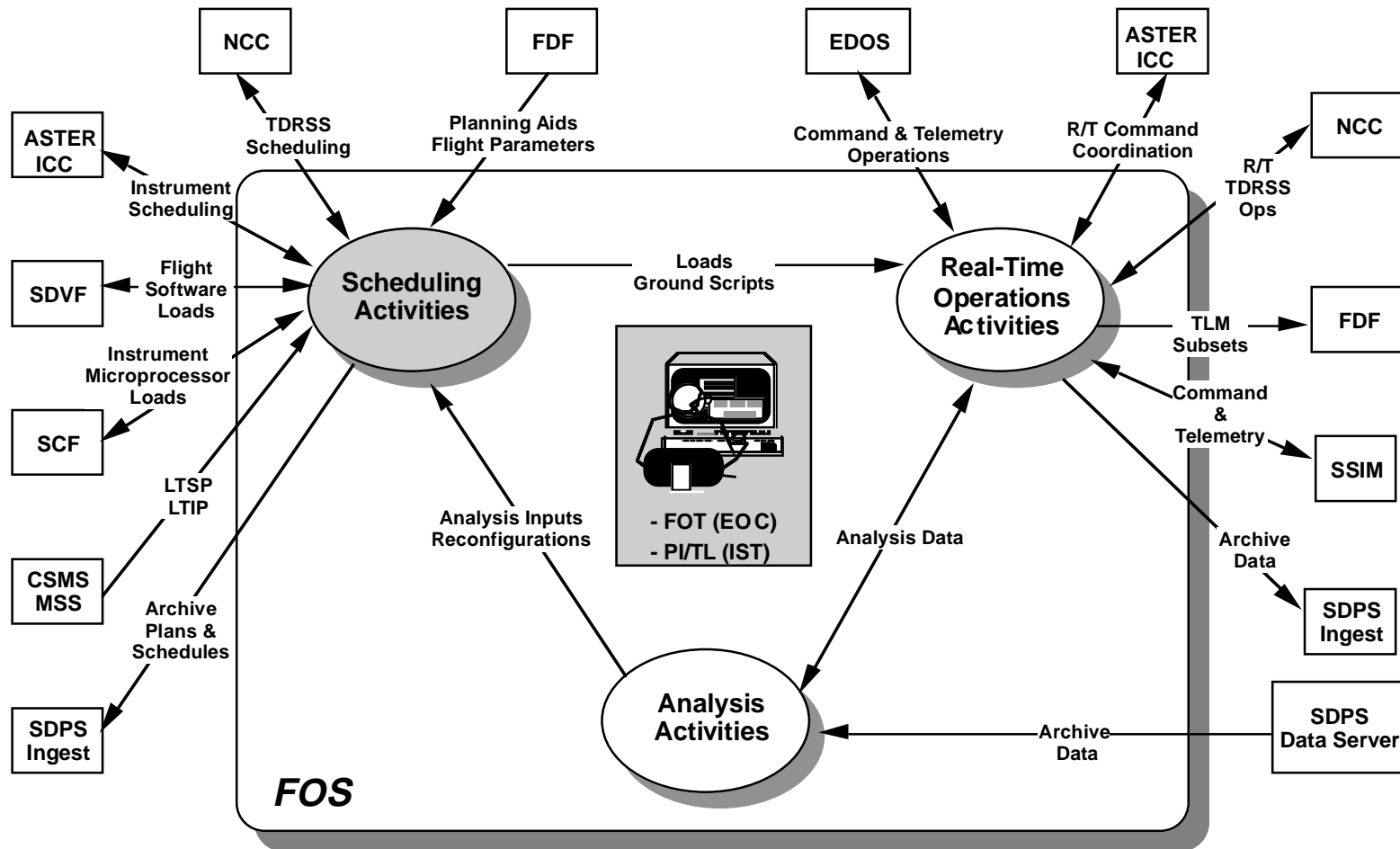
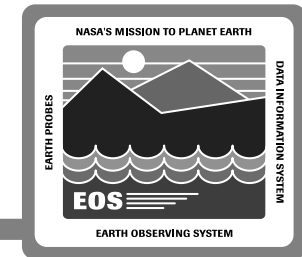
Scheduling Overview

Scheduling Context Diagram

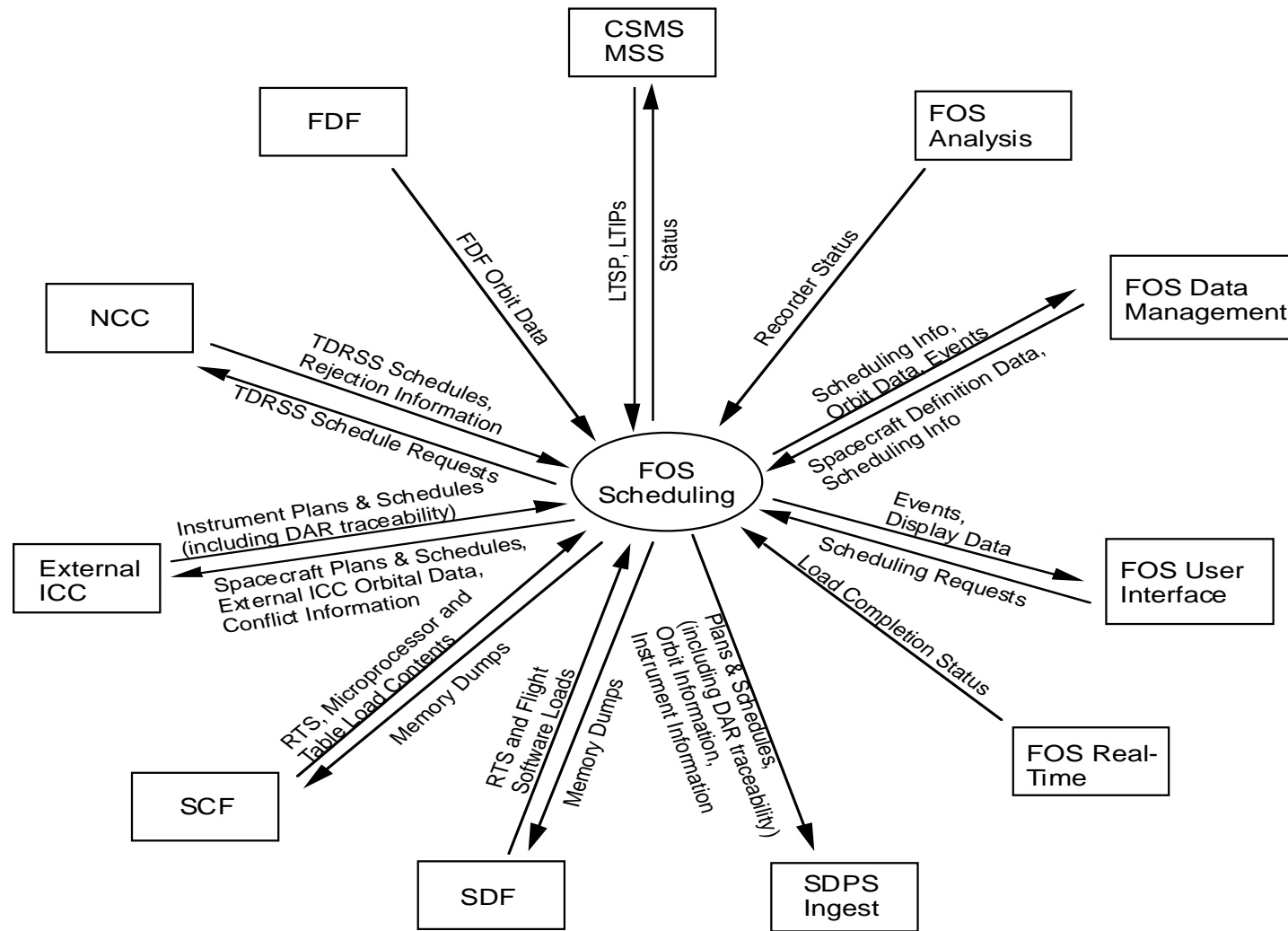
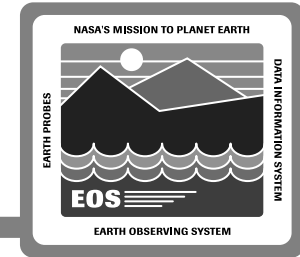
Design and Scenarios

- | | |
|----------------------|---------------|
| • Pre-Scheduling | Guy Swope |
| • Initial Scheduling | David Hyde |
| • Final Scheduling | Tony Cetuk |
| • Daily Scheduling | Neil Clabough |
| • Late Changes | Neil Clabough |

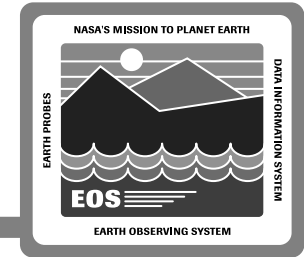
Scheduling External Interfaces



Scheduling Context Diagram



Scheduling Overview



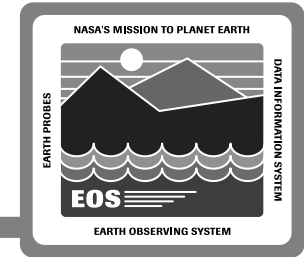
Primary Objectives:

- Produce an integrated, conflict-free schedule of activities for spacecraft, instrument and ground resources
- Create the spacecraft stored command load and ground script based upon the conflict-free schedule

Functions:

- Integrate and constraint check instrument and subsystem schedules
- Provide global visibility to conflict information throughout schedule development for conflict resolution
- Establish TDRSS contact times
- Generate the Absolute Time Command (ATC) load from the conflict free schedule
- Generate the Ground Script load from the conflict free schedule
- Manage the reception, creation and generation of RTS, Table, microprocessor and Flight Software loads

Scheduling Activity Scope



AM-1 with evolution to subsequent missions

Instruments

- **ASTER, CERES, MISR, MODIS, MOPITT**

Spacecraft subsystems

- **Power subsystem, Solid State Recorder, Navigation**

NCC TDRSS scheduling

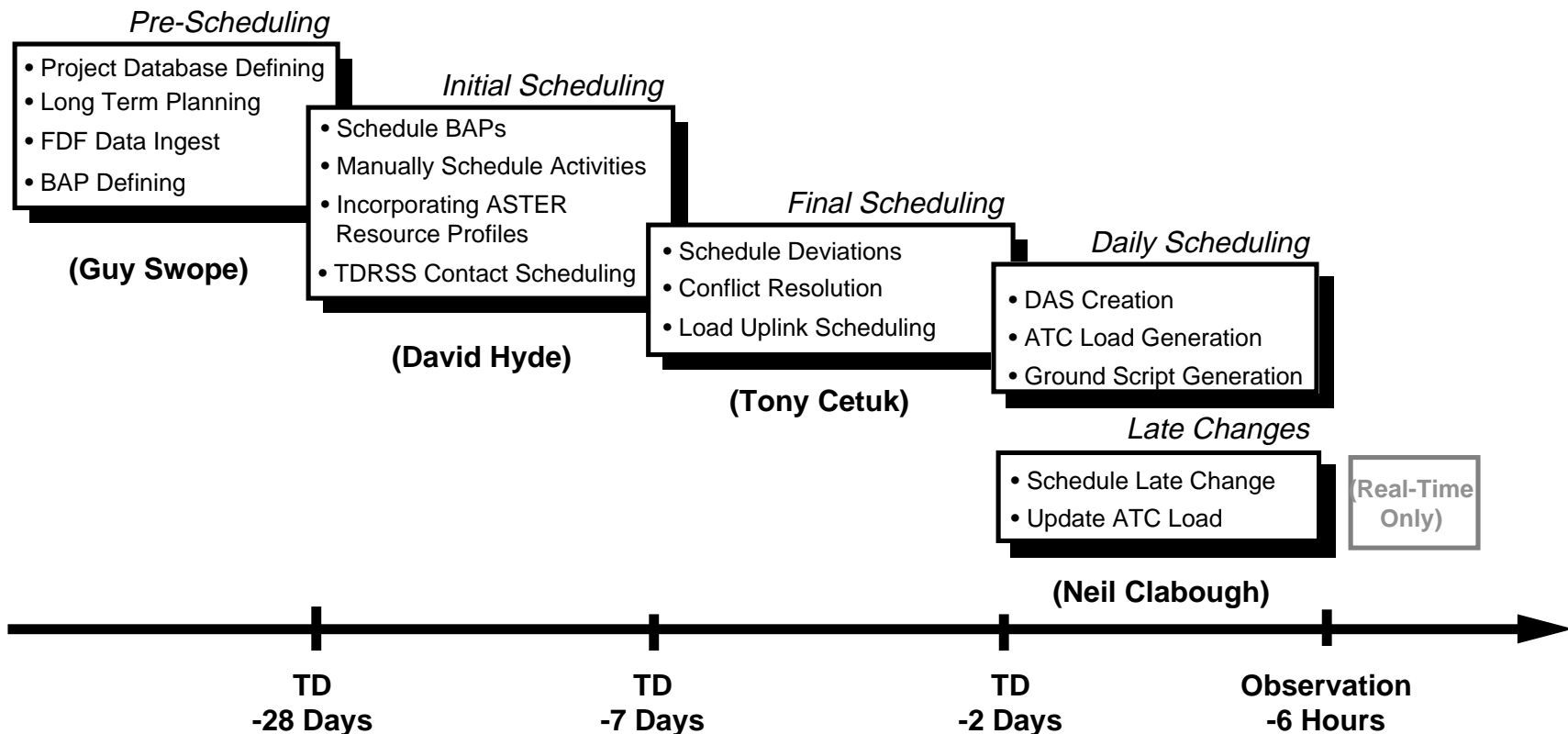
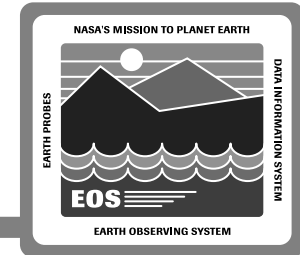
Ground resources

- **Wallops, DSN, GN**

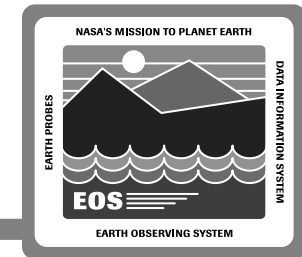
Geographically distributed Instrument planning teams

- **Japan, LaRC, Toronto, GSFC, JPL**

Scheduling Overview



Sample Day of AM-1 FOS Scheduling Activities



Example of concurrent scheduling activities occurring during a typical “day in the life”

March 2000						
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Monday, March 27, 2000

Pre-Scheduling

Target Day > 28 days

Initial Scheduling

Target Day > 7 days

Final Scheduling

Target Day > 2 days

Daily Scheduling

Target Contact > 6 hours

- EOC receives/reformats latest AM-1 FDF ephemeris and orbit events
- EOC distributes FDF Data to ISTs and ASTER ICC
- CERES IST modifies its Biaxial Scan Baseline Activity Profile definition
 - Uses BAP Definer tool to add Solar Calibration Activity

- CERES IST and other instrument teams submit Baseline Activity Profiles
- ASTER submits resource estimate
- EOC integrates instrument resource estimates with spacecraft activities
- EOC negotiates with NCC for TDRSS contacts

- MODIS schedules deviations from its Baseline Activity Profile
- ASTER submits activity list to EOC
- MISR IST schedules memory microprocessor load
 - Uses Load Scheduler Tool

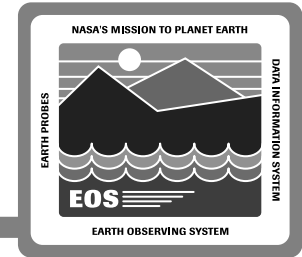
- EOC creates conflict free Detailed Activity Schedule
 - Uses Releaser Tool to lock 24 hour scheduling period
- EOC generates ground script and ATC load, schedules ATC uplink
- Due to an anomaly, EOC incorporates late change from MODIS

8 AM



5 PM

Scheduling Tools



Resource Model - Background process that models the behavior of the system

Activity Definer - Tool used to create, edit, store and remove activity definitions from the project database

BAP Definer - Tool used to create, edit, store and remove Baseline Activity Profile definitions from the project database

Label Activity Scheduler - Tool used to schedule mock (label) activities

Timeline - Tool for visually displaying the states of resources through time

Instrument Activity Scheduler - Tool used to schedule activities for instruments and spacecraft subsystems

Plan Permission - Tool used to restrict scheduling access

TDRSS Activity Scheduler - Tool for scheduling TDRSS contact times

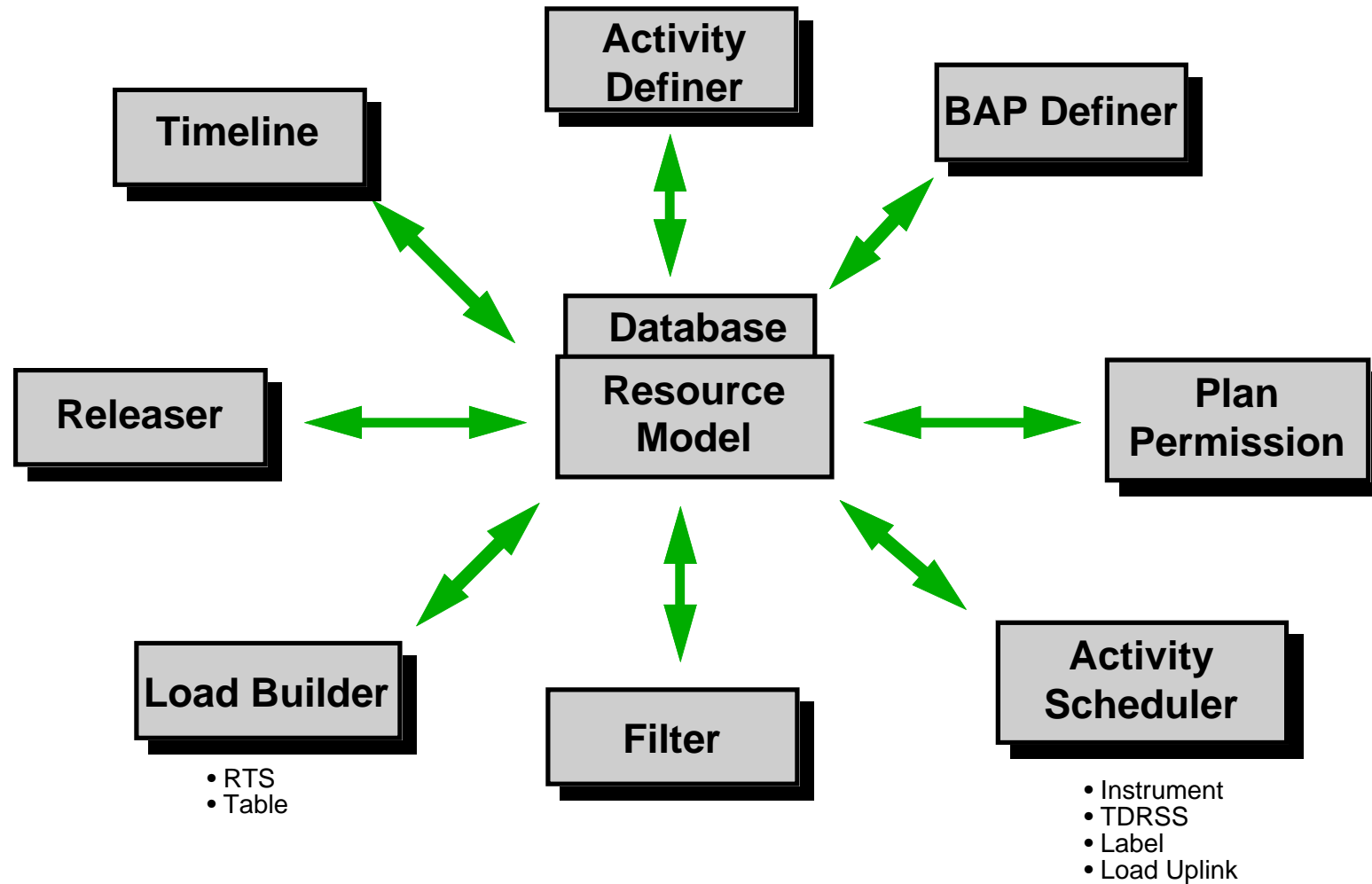
Load Uplink Scheduler - Tool for transferring loads to the EOC and for scheduling of load uplink times

RTS Load Builder - Tool for creating the contents of the RTS load

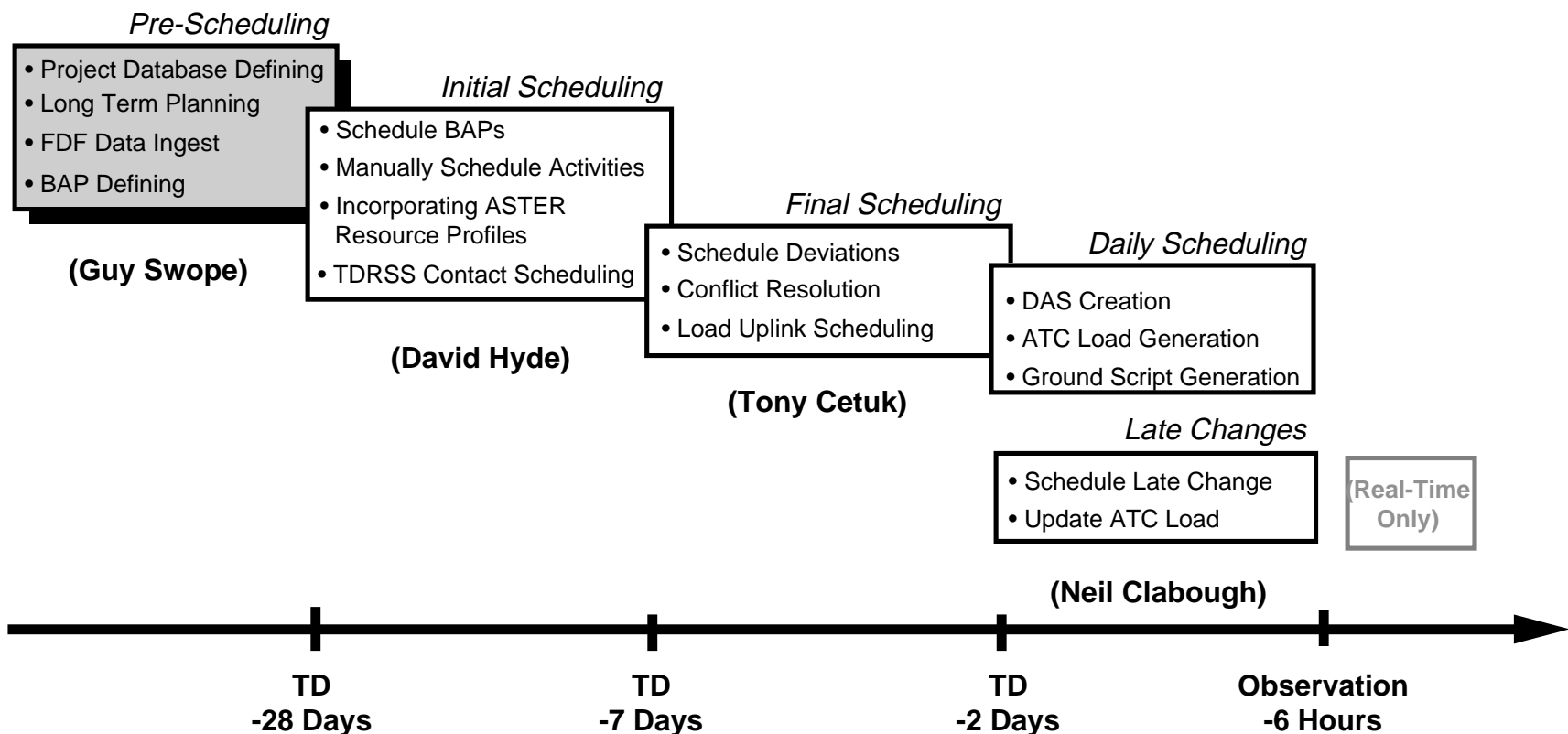
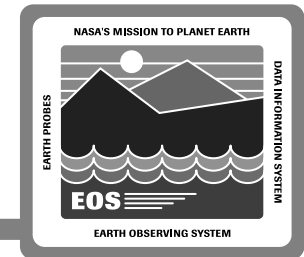
Table Load Builder - Tool for creating the contents of the table loads

Daily Plan Tool - Tool for releasing the Detailed Activity Schedule

Scheduling Tools (cont.)



Scheduling Overview



Pre-Scheduling Overview



Define project database

- **Build activity definitions**
- **Build instrument Baseline Activity Profiles from list of activities**

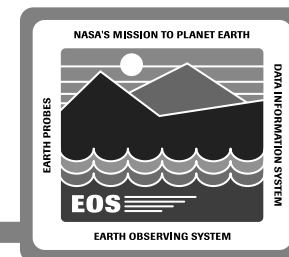
Handle Long Term Plans

- **Long Term Science and instrument plans from SMC**
- **Create Long Term spacecraft operations plans**

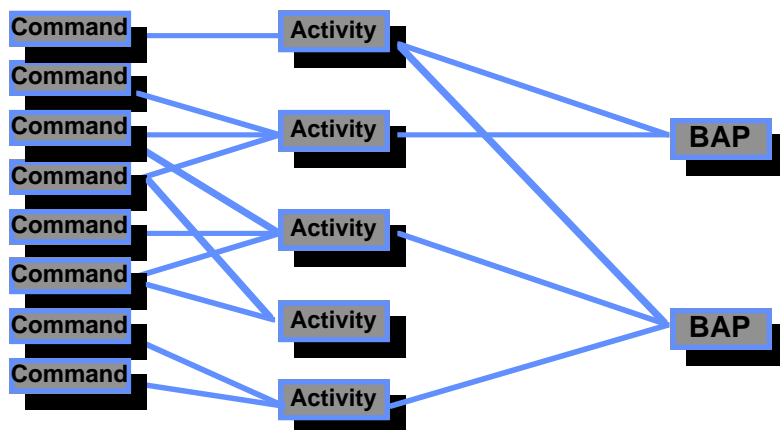
Handle FDF Planning Aids

- **Receive and reformat Flight Dynamics Facility Orbit Data**
- **Distribute FDF Orbit data to ISTs and ASTER ICC**

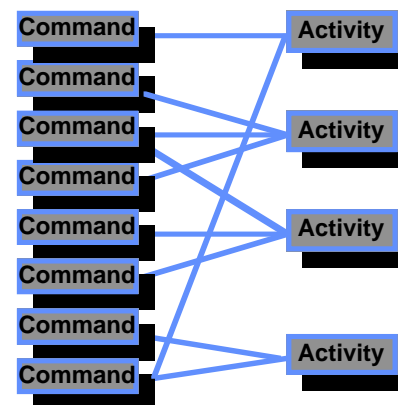
Activity to Command Mapping Example



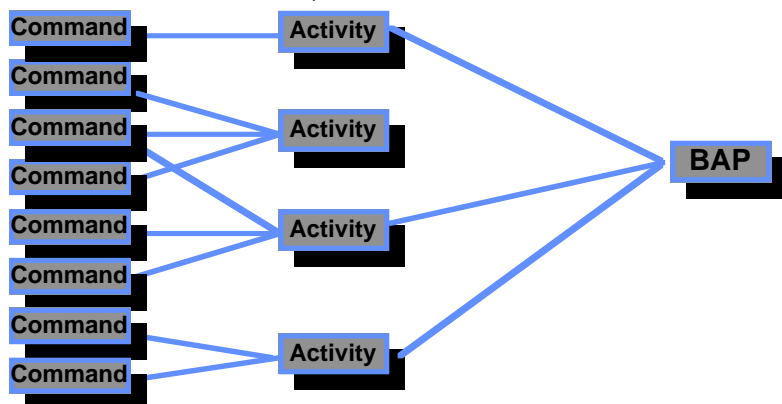
CERES Commands, Activities and BAPs



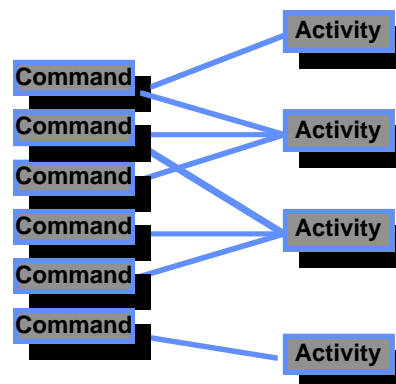
ASTER Commands and Activities



MODIS Commands, Activities and BAPs



MISR, MOPITT Commands and Activities



Activity Defining Description



Define activities for aid in Planning and Scheduling

Activities consist of

- One or many commands
- Parameters required for modeling spacecraft and instrument characteristics (e.g. power and data rate requirements)
- Parameters that affect activity expansion (e.g. command relative time offsets)

Activity parameter limits checked for health and safety

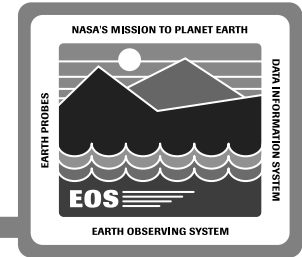
Activity Definitions created by Activity Definer tool, stored in the project database

- Changeable during life of mission
- Later used by Activity Scheduling tool

Allowing activities to map to one or many commands

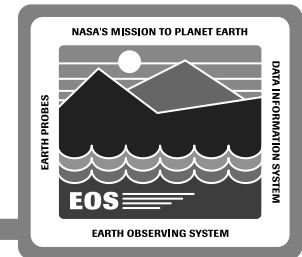
- Provides flexibility in scheduling - command or activity level
- Fills needs of many users

Activity Defining Object Diagram



See following page.

Activity Definer Display

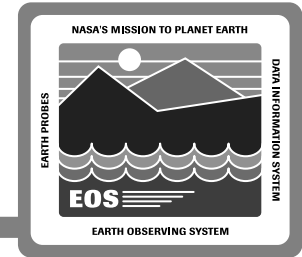


Activity Definer Window

Resource Type	Ceres
Activity ID	Ceres Biaxial Scan
Power	15 Watts
Data Rate	5 kbps
Commands	

Load Save Reset

CERES Activity Defining Scenario



CERES instrument planners, using the Activity Definer Tool, select resource type where activity will be scheduled

A new activity definition created with unique name (e.g. “CERES Biaxial Scan”)

CERES instrument planner creates/edits list of commands for a “CERES Biaxial Scan” using Procedure Builder

The “CERES Biaxial Scan” activity may represent :

- **Single command**
- **List of single commands**

Commands configured in project database

CERES planner sets values for :

- **Power and data rate parameters required for resource modeling**
- **Command relative time offsets for activity expansion**

CERES activity parameters checked for instrument health and safety

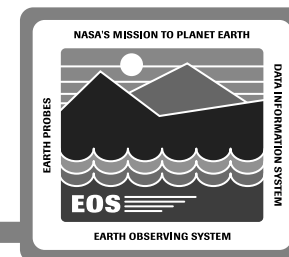
Activity Definition stored in the project database

BAP Defining Object Diagram



See following page.

BAP Defining Description



Define Baseline Activity Profiles used to aid Planning and Scheduling

Baseline Activity Profiles

- Represent a list of activities
- Used to simplify repetitive scheduling

Activities must be defined in project database

- Entered via Activity Definer tool

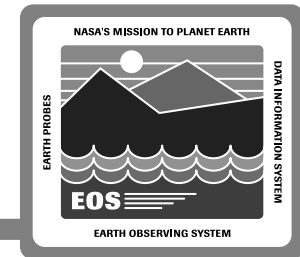
BAP Definition activities modifiable

- Specify event triggers
- Variable parameters

BAP Definition stored in project database

- Changeable during life of mission
- Later used by Activity Scheduling tool

BAP Definer Display



BAP Definer Window

Resource Type:

BAP Name:

BAP Period:

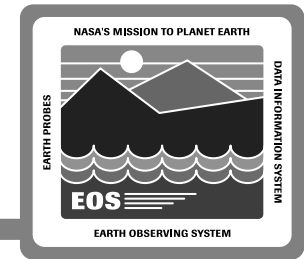
Activity List

<input checked="" type="checkbox"/> Biaxial Short Scan	<input type="button" value="Add"/> <input type="button" value="Edit"/> <input type="button" value="Delete"/>
<input type="checkbox"/> Biaxial Scan	
<input type="checkbox"/> Solar Calibration	

Activity Types

<input checked="" type="checkbox"/> Biaxial Short Scan
<input type="checkbox"/> Biaxial Scan
<input type="checkbox"/> Fixed Scan
<input type="checkbox"/> Solar Calibration

CERES BAP Defining Scenario



CERES instrument planners, using BAP Definer Tool, select CERES as resource type where BAP activities will be scheduled

New BAP definition created with Planner specifying unique name (e.g. “CERES Biaxial Scan Baseline Activity Profile”)

CERES instrument planner selects activities, adding them to BAP list (e.g. a “Biaxial Scan Activity” followed by a “Biaxial Short Scan Activity”)

“Biaxial Short Scan Activity” edited to define orbital event that will trigger activity (e.g. a sunrise or sunset event using the Activity Definer tool)

Repeat period for BAP (e.g. 1 orbit) entered

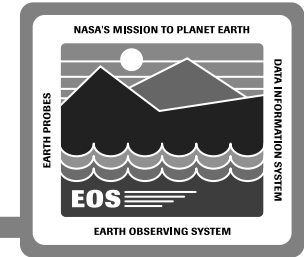
Baseline Activity Profile Definition stored in FOS database

Long Term Planning Object Diagram



See following page.

Long Term Planning Description



Handle Long Term Plans

- Receive Long Term Science and Instrument Plans from SMC
- Create Long Term Spacecraft Operations Plan
- Store plans in database

Plans stored in textual format in FOS Data Management

All plans retrievable in text form

Instrument and spacecraft activities can be viewed on timeline

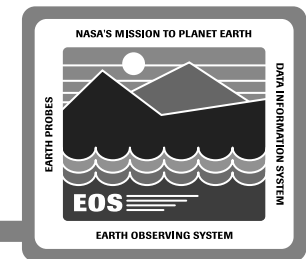
- Use Label Activity Scheduler
- Visual display of plan on timeline

Visual display of plans

- Provides common tool
- Assists instrument and spacecraft FOT planners

Portions of instrument and spacecraft plans can be retrieved in timeline display form

Long Term Plans Display



Label Activity Scheduler

Resource Type: EOS Spacecraft

Activity Types:

- Label Activity

Activity ID: 2341562

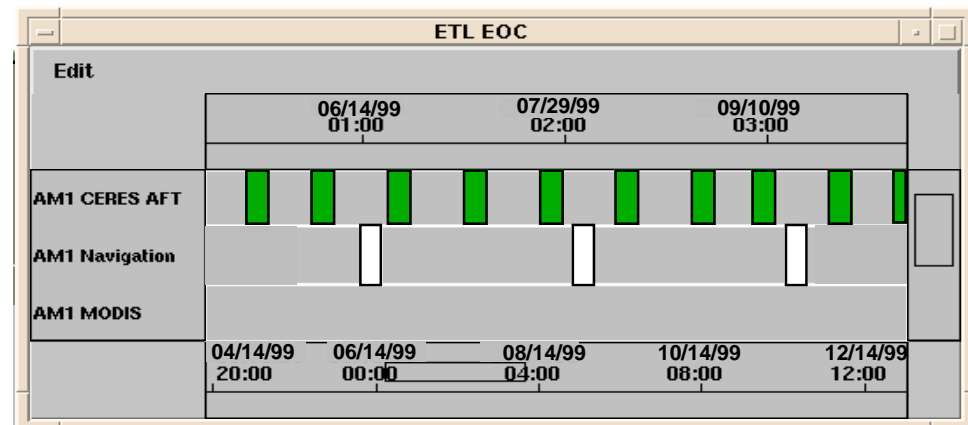
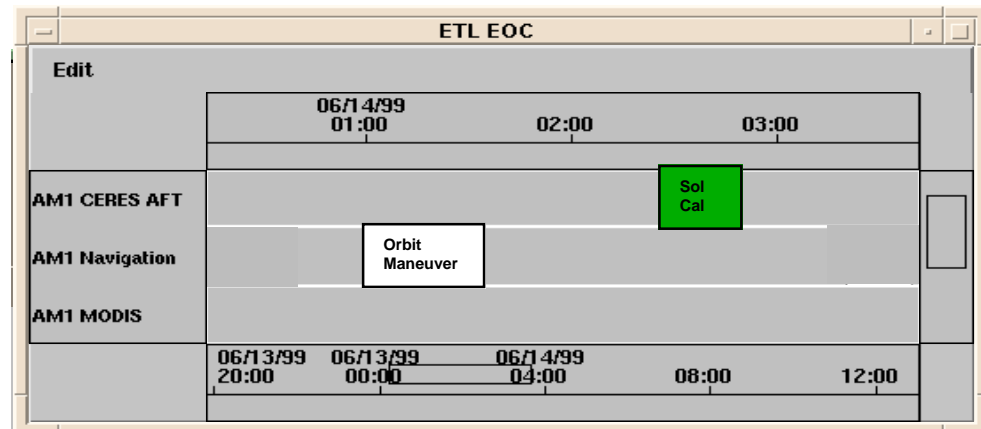
Activity Name: Yaw Maneuver

Color: green

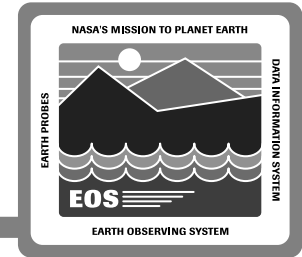
Start: 1 Jan 1998 00:00:00

Stop: 3 Jan 1998 16:30:30

Resource: AM1 Spacecraft



Long Term Planning Scenario



Long Term Science and Instrument Plans for AM-1 received by FOS from SMC

Long Term Science and Instrument Plans for AM-1 stored in project database in text format

FOT personnel generate AM-1's Long Term Spacecraft Operations Plan in text form

The Label Activity Scheduler used to lay out five-year orbit maneuver plan for AM-1 spacecraft

FOT operator

- **Selects resource AM-1**
- **Selects "Label Activity"**
- **Gives "Label Activity" name, "Orbit Maneuver", and color**
- **Schedules "Label Activity"**

"Label Activity" displayed on timeline as a mock "Orbit Maneuver" activity

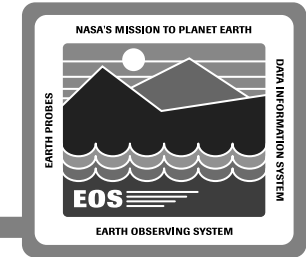
AM-1 orbit maneuver visual plan stored in FOS database

FDF Data Ingest Object Diagram



See following page.

FDF Data Ingest Description



Handle FDF Planning Aids

- Receive and reformat Flight Dynamics Facility Orbit Data
- Distribute FDF Orbit data to ISTs and ASTER ICC

FDF Planning Aids consist of :

- Ephemeris and attitude offsets for orbit maneuver
- Orbital events including spacecraft ground track
- TDRSS contact availability periods
- Predicted site acquisition tables (PSATs)

Reformatted for scheduling use and table load generation

FORMATS trade study

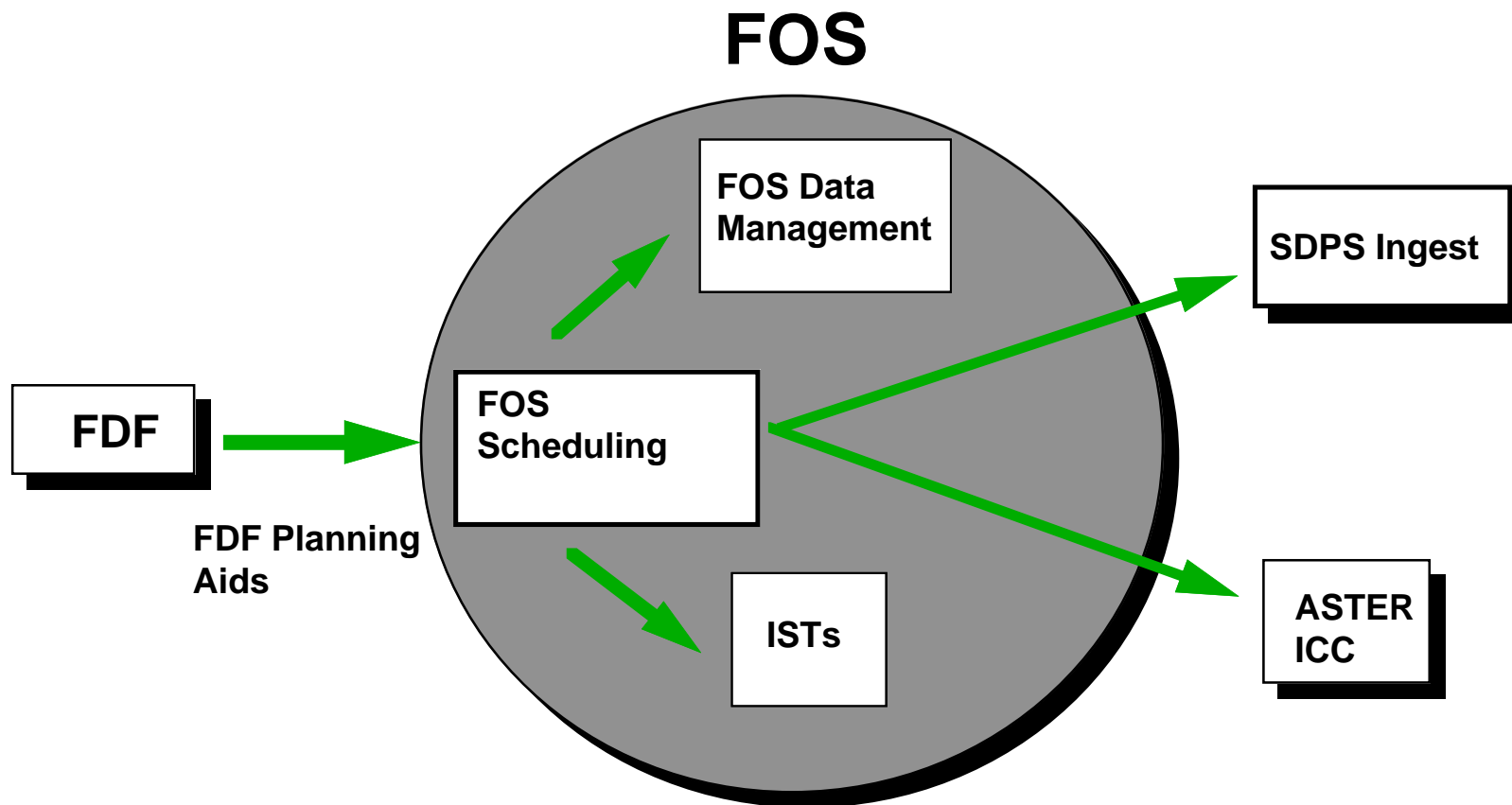
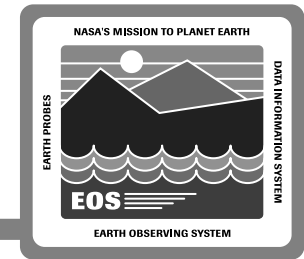
- Preliminary analysis results favor use of FORMATS

Orbital events modeled as spacecraft states

- IST visibility for instrument planners
- Distribution handled automatically

Ephemeris distributed via database due to large volume of data

FDF Data Flow Diagram



AM-1 FDF Ingest Scenario



AM-1 orbital data received from Flight Dynamics Facility at GSFC EOC
FDF Data automatically reformatted by FORMATS and stored in project database

FDF Data sent to SDPS Ingest

FOT personnel, using Table Load Builder, generate FDF Table Loads for future uplink to AM-1 spacecraft

Orbital events reformatted for AM-1 spacecraft state model

TDRSS availability periods modeled as TDRSS spacecraft state

AM-1 and TDRSS state models allow

- **Automatic distribution to geographically distributed ISTs and ASTER ICC**
- **Display via timeline at EOC and IST to assist FOT and instrument planners**